Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554

In the Matter of Expanding Flexible Use of the 3.7 GHz to 4.2 GHz Band	**GN Docket No. 18-122**

Comments of iPosi, Inc.

Introduction

In its Public Notice of May 1, 2018 ("PN"), the Commission's Office of Engineering and Technology ("OET") pursuant to the Section 605(b) of the MOBILE NOW Act asks for public comment to use or share the frequencies between 3.7 and 4.2 GHz. The object of this Bill's Section is to provide definitive information regarding feasible new operations with either outright cleared and re-purposed licensed operations as well as same-channel ("co-channel") sharing.

The PN provides three guidance seeking questions for comment: 1) How should we assess the operations and possible impacts of sharing on Federal and non-Federal users already operating in this band?; 2) How might sharing be accomplished, with licensed and/or unlicensed operations, without causing harmful interference to Federal and non-Federal users, and in which parts of the band would such sharing be feasible?; 3) What other considerations should the Commission take into account in preparing the 3.7 – 4.2 GHz Report?

The PN points out that currently there are no Federal users. We infer the PN contemplates potential Federal usage alongside or in cooperation with private sector sharing of the band, and in that event, OET would like to be in position to respond to that case in subsequent Congressional hearings.

iPosi, Inc., Boulder CO, ("iPosi") is a private wireless technology company developed technologies in embedded GPS/GNSS signal receiver design and signal sensing applicable to 4G, 5G, CBRS and Trusted Time solutions. It presents these Comments for Commission and OET consideration and recommendations related to preparation for its 2019 Report to Congress on this matter.

I. How should we assess the operations and possible impacts of sharing on Federal and Non Federal users already operating in this band?

Assumed or guiding principles to support C Band share-or-clear policy decision making:

- Current legacy operations shall be protected against harmful co- and adjacent band interferences.
- Any forward sharing case must demonstrate no harm would exist to commercially deployed systems.
- Legacy operations also have responsibility to use the spectrum resource efficiently.
- New shared (and band-exclusive) operations must also protect to the same extent as co-channel the adjacent band harmful interference criteria. Prominent here is OOBE and LNB saturation.

- CBRS is advancing. It has a defined eco-system and is in a formal certification process to rigorously test under all sharing scenarios, including protection of vital national security operations such as US Navy maritime long-range coastal radars.
- In the current case, an element of CBRS, the ESC, is not a transferrable element outside the 3.55GHz legacy Navy radar case. FSS Earth Stations receive very low power geo-stationary satellite signals which unlike CBRS radar sensing ESC, it cannot discriminate legacy operations that are ever-present and provide only weak incoming signals to annunciate their presence.
- True dynamic sharing of this band should employ scalable SAS intelligence but will require a secure and intelligent-path measurement mechanism to radio isolate contending operations from harmful interference.
- Wholesale clearing of the 3.7-4.2 GHz band poses its own unique problems or issues, including loss of a valuable, non-fungible C Band Video transmission resources, large capital and other transaction outlays associated with a make-before-break transition, multiple party dispute resolution adjudication mechanisms that are unwieldy and burdensome, foreseen and likely unforeseen transition delays including adapting to new operating bands where ready fiber and service SLA and business relationships are infeasible or do not exist.
- Added to the preparatory phase of a wholesale clearing transition, the clearing scenario analysis must account for additional delay in commissioning new equipment *in volume*, network and terminals, in sufficient production to serve the national, not small regions of 5G need.
- Practical clearing is not only the time to secure new band(s), administer funds to reimburse and install equivalent networks to operate in new bands. It must also include the time to reach a productive level of available spectrum to incentivize production of new equipment. These are not parallel in time, they are serial, thus measured more in a decade or more than merely months or years. Public interest is not well served by exclusively opting for this approach.
- The hidden and direct administrative costs of staff, field measurements of presenting new band operations all adds another layer of significant "shadow" cost and complexity.

Therefore, we recommend the Commission consider a much less wasteful option of blending the best of both sharing and sub-band clearing to sensibly increase readiness and reduce transition costs to re-purpose so much spectrum and maintain the nation's highly productive C Band infrastructure.

II. How might sharing be accomplished, with licensed and/or unlicensed operations, without causing harmful interference to Federal and non-Federal users, and in which parts of the band would such sharing be feasible?

Co-frequency dynamic sharing of the band requires assigning frequencies so interference is avoided between the shared systems or that interference is managed in a mutually aware fashion between the systems. Typically the systems of concern are broadband versus FSS and in the present CBRS band, versus DoD/US Navy Radar. The CBRS system with the use of SAS already provides the management instrument to avoid interference and audit its potential.

However, this method requires that spectrum be unused where interference might occur as computed by path loss models. For the in building CBRS or small cell case, the present rule-based fixed figure building loss is 15 dB, which is directly added to distance-based path loss to determine and not exceed the legacy

interference threshold. The 15 dB rule-based loss is often overly pessimistic (in fact, the same fixed figure rule ironically can lead to underestimating victim receiver interference if true building loss is less). In the case of through-building radio propagation loss toward the victim being higher, the rule denies radio resources, either the channel or power otherwise measured and safely available for assignment.

To measure out-going signal building loss, we deploy a solution based on symmetrical incoming (that is, into the building) loss along the same radio ray-path (sensitive to azimuth and elevation). Using a radio signal sounding method, which is accomplished using a fixed GPS/GNSS receiver with sensitivity of -175 to -183 dBm (L1 or L5) signal as the radio sounding wave penetrating the building), this is capable of measuring up to 55 dB building signal entry or exit loss along geometrically defined radio ray-paths.

This is not a new function. The same extreme sensitivity GPS/GNSS receiver is embedded to synchronize LTE independently at each cell and provide useful 3D coordinates to locate mobile devices based on measured cell 3D position and interior LTE or Wi-Fi range-signal positioning. With a low cost client (ASIC and software) embedded in the CBRS small cell, a continuous measurement provides a known quantified outbound signal loss in any direction over a the incoming sounding signal hemisphere. The loss measured at between GNSS/GPS can be either ignored thus provide loss measurement conservatism (loss at 3.7-4.2 GHz is systematically greater than at the higher carrier frequencies than at 1.6 GHz GPS/GNSS) or can be algorithmically translated with a loss factor to match the expected RF loss difference between 1.6 GHz and 3.5 to 4.2 GHz. These losses are well established in the art, among those are measurements for a wide number of building loss measurements by NIST (1997)[1].

WinnForum recently accepted building loss measurements based on fixed indoor GPS receiver multi-satellite signal power relative to known outside power level in its Release 2.

Increase in interference-free shared frequency capacity directly relates to the available radiant energy isolation between operations to avoid harmful co-channel interference. In common building loss cases, in situ radio path-intelligent measurement losses often exceed 35 dB building signal entry or exit loss on a ray-path toward a known victim or the geographic area in which legacy receivers are known to operate. To illustrate that common isolation "capacity" already freely existing to protect shared operations, we reference and compare this to CRBS rule-based 15 dB building loss, which is not measured and may be too loose or conservative. When the building loss precisely measures the actual losses (including relevant antenna pattern details) the additional loss can readily gain 100-times of radio resource, to produce 100X capacity gain in data throughput, transmit power, or both as the SAS determines best within its programmed constraints.

5G is expected to have heaviest peak and average traffic profiles indoor. This is also where the least network resources exist today to ensure seamless 5G gigabit grade communication with low latency data delivery. Further, competitive device technology is greatest where they can access mid-frequency bands that have more conducive propagation than higher millimeter bands. Based on these premises, we conclude opening spectrum resources to encourage all-area 5G but aim sharing opportunity where it's most needed. iPosi recommends proportionate blending of "pure" spectrum clearing with "pure" sharing to eliminate the worse characteristics attending either and promote progress commercially and ensure vigilant interference-free operations. This blended or hybrid is consistent with lessening transition costs

[1] Stone, William C. NIST Construction Automation Program Report No. 3 Electromagnetic Signal Attenuation in Construction Materials. NISTIR 6055, 1997

and holdout premiums associated with holders potentially demanding premium spectrum-exiting fees while 5G services are not yet competitively marketed and ability to pay premium is accompanied by higher investment risk. We therefore suggest a similar proportion again: retain 80% or 400 MHz legacy C Band services and applications, and continue to serve video programming customers. This continues while enabling shared indoor service grows and where isolation from those low power highly isolated shared systems is greatest.

One of the larger interests in terms of C Band video service is Comcast[2] and in its recent ex parte presentation points out amply that preservation of C Band is critical to operational quality, deployment flexibility, and productivity. While physical fiber substitutes at the margin for a percentage of FSS station installations many reasons exist to maintain current C Band systems. Their presentation illuminates the point that there is no credible scenario supporting widescale C Band video services extinction. Indeed, for many commercially significant reasons, C Band must remain in video programmer and content deliverer's arsenal.

- CBRS is a cloud based, intelligence-based co-channel sharing regime capable of developing substantially higher re-use if radio path intelligence between shared services is properly incorporated.
- CBRS meets mission-critical sharing objectives including challenging US military radar protection criteria.
- CBRS provides a highly scalable spectrum resource management system. This goes beyond radio resource dispensing, it can provide on demand radio resource auditing including active interference and interference margin management services.
- CBRS and SAS systems offer a path toward real time measurements based intelligent-path measurements.
- Indoor CBRS especially with 5G contemplates most, 80% is commonly forecast, that is or will be used inside buildings for enterprise or consumer applications.

Above, we show significant capacity to share exists to build indoor 5G services while protecting legacy FSS C Band services using proper radio path-intelligence which includes information regarding the indoor containment of CBRS cell signal over a hemispherical azimuth and elevation pattern. As stated earlier, path-intelligence combines conservative path loss estimation by WinnForum and others, including free space propagation. Together, these in-to-outside propagation with urban or free space prediction provide with large practical margins to isolation both co- and adjacent channel sharing operations.

III What Other Considerations Should the Commission Take into Account in Preparing the 3.7-4.2 GHz report?

We believe OET should consider all economic factors related to partial and whole-band clearing scenarios. We encourage OET to assess the cost of partial band re-purposing (such as our proposal sets forth to only clear 20%, or 100MHz immediately) against a complex, long term and improbable to achieve consensus clearing scenario of the entire 500 MHz, even if done over extended phases.

[2] May 10, 2018 Electronic filing to Marlene H. Dortch, Secretary, Federal Communications Commission, containing Ex Parte presentation by Comcast Corporation entitled, "Critical C Band Operations", May 2018.

We believe OET should consider the CBRS architecture and eco-system as enabling increasing scope of a broad variety of Federal and non-Federal Mid-Band Frequency sharing opportunities which is feasible and consistent with international trends underway to operate in the same frequency band neighborhood.

We believe OET should, through this proceeding and others, encourage stakeholders, Federal and non-Federal, to seek more alternatives that only clear-and-sell to raise practical use and efficiency and avoid turning spectrum into a ransoming resource. This impedes innovation, and reduces spectrum management which includes increased interference vigilance using active shared frequency management intelligent systems.

Conclusions

Within this 3.7 to 4.2 GHz proceeding, iPosi recommends the Commission approach its inquiry employing a blended "Clear & Share" approach, clearing partially up to 100MHz (and chosing the particular 100MHz contiguous sub-band) based on operational, optimal band edge LNB saturation and OOBE impacts and their avoidance, as well as assess and resolve the best path toward achieving minimal licensee impact to effect partial clearing. We recommend the Commission seek the broadest review consistent with maintaining 400 MHz of current C Band licensed services, continuing flexible and growth-as-needed legacy operations while at the same time support sharing those 400 MHz with indoor CBRS and SAS based services. Note that all 500 MHz may be shared consistent with preserving interference within the 5G services operating on cleared spectrum. We put forth these recommendations based on use of intelligent-path measurement methods consistent with evolving WinnForum shared radio system standards.

Respectfully submitted,

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May 31, 2018